80/223/CDV

ENQUIRY DRAFT FOR VOTE (CDV)
PROJET D'ENQUÊTE POUR VOTE (CDV)

	Project number Numéro de projet 80/61996 Ed. 1	
IEC/TC or SC: **80** CEI/CE ou SC:	Date of circulation Date de diffusion **1999-03-19**	Closing date for voting (Voting mandatory for P-members) Date de clôture du vote (Vote obligatoire pour les membres (P)) **1999-08-31**
Titre du CE/SC:	TC/SC Title: Maritime navigation and radiocommunication equipment and systems	
Secretary: P F C GRIFFITHS - United Kingdom Secrétaire:		
Also of interest to the following committees Intéresse également les comités suivants	Supersedes document Remplace le document 80/135/NP - 80/142/RVN	
Horizontal functions concerned Fonctions horizontales concernées ☐ Safety / Sécurité ☐ EMC / CEM ☒ Environment / Environnement ☐ Quality assurance / Assurance qualité		

Titre :

Title :

Maritime navigation and radiocommunication equipment and systems – Shipborne voyage data recorder (VDR) – Performance requirements – Methods of testing and required test results

Note d'introduction

The French text of this document has not been made available

Introductory note

The future IEC 61996 has been developed by IEC TC 80 Working Group 11. The Working Group has called upon experts from throughout the world. These included the aeronautical industry and aircraft accident investigation organisations who have much previous experience in the design and use of aircraft flight recorders.

One outstanding problem remains, concerning the detail and availability of typical radar/SENC images for the subjective evaluation of the recorded images. (see 6.2.4.7 and note of the draft)

It is the intention that this problem will be solved within the next 2 months, and the solution circulated to all TC 80 members during the CDV voting period.

A bilingual version of this standard may be available at a later date.

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	**Parallel IEC CDV/CENELEC Enquiry**

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS –

Shipborne voyage data recorder (VDR) – Performance requirements – Methods of testing and required test results

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of the IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61996 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

The text of this standard is based on

FDIS	Report on voting
XXX/FDIS	XXX/RVD

Annexes A, B and C are for information only.

A bilingual version of this standard may be published at a later date.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS

Shipborne voyage data recorder (VDR) – Performance requirements – Methods of testing and required test results

1 Scope

This International standard specifies the minimum performance requirements, technical characteristics and methods of testing, and required test results, for shipborne voyage data recorder (VDR) installations as required by Chapter [V] of the International Convention for Safety of Life at Sea (SOLAS): 1974, as amended. It takes account of IMO resolution A.694 and is associated with IEC 60945. When a requirement in this standard is different from IEC 60945, the requirement in this standard takes precedence.

This standard incorporates the applicable parts of the performance standards included in IMO Resolution A.861.

NOTE – All text of this standard, whose wording is identical to that in IMO Resolution A.861 is printed in *italics* and the Resolution and associated performance standard paragraph numbers are indicated in brackets.

2 References

2.1 Normative

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 68-2-27:1987, *Environmental testing – Part 2: Tests – Part 27: Shock*

IEC 268:1988, *Sound system equipment – Part 16: The objective rating of speech intelligibility in auditoria by the "RASTI" method*

IEC 651:1979, *Sound level meters*

IEC 60945:1996, *Maritime navigation and radiocommunication equipment and systems – General requirements – methods of testing and required test results*

IEC 61097-2:1994, *Maritime navigation and radiocommunication equipment and systems – Global maritime distress and safety system (GMDSS) – Part 2: COSPAS SARSAT EPIRB – Satellite emergency position-indicating radio beacon operating on 406 MHz – Operational and performance requirements, methods of testing and required test results*

IEC 61097-5:1997, *Maritime navigation and radiocommunication equipment and systems – Global maritime distress and safety system (GMDSS) – Part 5: Inmarsat-E – emergency position-indicating radiobeacon (EPIRB) operating through the Inmarsat system – Operational and performance requirements, methods of testing and required test results*

IEC 61097-7:1996, *Maritime navigation and radiocommunication equipment and systems – Global maritime distress and safety system (GMDSS) – Part 7: Shipborne VHF radiotelephone transmitter and receiver – Operational and performance requirements – methods of testing and required test results*

IEC 61162 series, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces*

IEC 61260:1995, *Electroacoustics – Octave-band and fractional-octave-band filters*

IMO A.658:1989, *Use and fitting of retro-reflective materials on life-saving appliances*

IMO A.662:1989, *Performance standards for float-free release and activation arrangements for emergency radio equipment*

IMO A.689:1991, *Testing of life saving appliances*

IMO A.694:1991, *General requirements for shipborne radio equipment forming part of the Global maritime distress and safety system (GMDSS) and for electronic navigational aids*

IMO A.810:1995, *Performance standards for float-free satellite emergency position-indicating radio beacons (EPIRBs) operating on 406 MHz*

IMO A.812:1995, *Performance standards for float-free satellite emergency position-indicating radio beacons (EPIRBs) operating through the geostationary INMARSAT satellite system on 1,6 GHz*

IMO A.830:1995, *Code on alarms and indicators*

IMO A.861: 1997, *Performance standards for shipborne voyage data recorders (VDRs)*

ITU-R M.632-3:1997, *Transmission characteristics of a satellite emergency position-indicating radio beacon (satellite EPIRB) operating through geostationary satellites in the 1,6 GHz band*

ITU-R M.633-1:1990, *Transmission characteristics of a satellite emergency position-indicating radiobeacon (satellite EPIRB) system operating through a low polar-orbiting satellite system in the 406 MHz band*

Eurocae: ED56A – *Minimum operational performance specification (MOPS) for cockpit voice recorder system*

VESA :1996, *Video electronics standards association – Discrete monitor timings standard 1.0, Revision 0.7 (DMTS)*

SAE AS8045: 1988, *Engineering Society for advancing mobility land sea air and space - Minimum performance standard for underwater locating devices – acoustic-self-powered*

2.2 Bibliography

A bibliography of relevant International documents is in annex A.

3 Definitions and abbreviations

3.1 Definitions

3.1.1
voyage data recorder (VDR) (A.861/4.1)
a complete system, including any items required to interface with the sources of input data, for processing and encoding the data, the final recording medium in its capsule, the power supply and dedicated reserve power source

3.1.2
sensor (A.861/4.2*)*
any unit external to the VDR to which the VDR is connected and from which it obtains data to be recorded

3.1.3
final recording medium (A.861/4.3)
the item of hardware on which the data is recorded such that access to it would enable the data to be recovered and played back by use of suitable equipment

3.1.4
playback equipment (A.861/4.4)
the equipment, compatible with the recording medium and the format used during recording, employed for recovering the data. It includes also the display or presentation hardware and software that is appropriate to the original data source equipment. Playback equipment is not normally installed on a ship and is not regarded as part of a VDR for the purposes of this international standard

3.1.5
dedicated reserve power source (A.861/4.5)
a secondary battery, with suitable automatic charging arrangements, dedicated solely to the VDR, of sufficient capacity to operate it as required by 4.5.3

3.1.6
resolution
the smallest detectable increment between two values

3.1.7
data
any item of information received by the VDR for recording, including numerical values, text and audio or radar signals, except where specifically stated or the context dictates otherwise

3.1.8
activation of a suitable alarm
a mutable audible alarm and a persistent visual indication are given, to the requirements of A.830

3.1.9
bridge work station
a position at which a crew member is expected to be when performing one of the normal bridge duties at e.g., the following work stations

- centre line conning
- bridge wing(s)
- main radar
- chart table
- helmsman
- communication

3.2 Abbreviations

IMO	International Maritime Organization
ITU	International Telecommunication Union
OOW	Officer of the Watch
ROV	Remotely operated vehicle
SINAD	Signal to noise and distortion
STI	Sound transmission index

4 Performance requirements

4.1 Introduction

Performance requirements described in this clause are specified by reference to the numbered paragraphs of IMO Resolution A.861.

4.2 Purpose (A.861/1)

The purpose of a Voyage Data Recorder (VDR) is to maintain a store, in a secure and retrievable form, of information concerning the position, movement, physical status, command and control of a vessel over the period leading up to, and following, an incident having an impact thereon. This information is for use during any subsequent investigation to identify the cause(s) of the incident.

4.3 General requirements (A.861/5)

4.3.1 Design and construction (A.861/5.1.4)

The design and construction, which shall *be in accordance with the requirements of resolution A 694(17) and international standards acceptable to the* International Maritime *Organization* (IMO*),* shall *take special account of the requirements for data security and continuity of operation as detailed in* 4.4 and 4.5.

4.3.2 Maintenance *of sequential records* (A.861/5.1.1)

The VDR shall *continuously maintain sequential records of pre-selected data items relating to the status and output of the ship's equipment, and command and control of the ship, referred to in* 4.6.

4.3.3 *Co-relation in date and time* (A.861/5.1.2, 5.4.1)

To permit subsequent analysis of factors surrounding an incident, the method of recording shall *ensure that the various data items can be co-related in date and time during playback on suitable equipment.*

The recording method shall *be such that the timing of all recorded data items can be derived on playback with a resolution sufficient to reconstruct the history of an incident in detail.* (see 4.6.1)

4.3.4 *Protective capsule* (A.861/5.1.3)

4.3.4.1 *The final recording medium shall be installed in a protective capsule*

The capsule shall *meet all the requirements* of 4.3.4.2 and 4.3.4.3.

4.3.4.2 *The capsule shall be capable of being accessed following an incident but secure against tampering*

The capsule shall enclose the final recording medium. The final recording medium shall not be accessible by standard operating procedures during normal ship operations.

A means shall be provided to retrieve stored information via an external device without opening the protective capsule.

4.3.4.3 *The capsule shall maximise the probability of survival and recovery of the final recorded data after any incident*

4.3.4.3.1 Form of construction of the capsule

The capsule containing the final recording medium may be designed to remain fixed to the ship in all circumstances. Alternatively, it may be designed to float free automatically if the ship sinks (see 5.2).

The capsule shall be designed to protect the stored data against the following (see 5.4):

- Shock
- Penetration
- Fire
- Deep sea pressure and immersion

4.3.4.3.2 Visibility and marking

The capsule, together with any outermost shell, *shall be of a highly visible* fluorescent orange *colour, marked with retro-reflective materials* that comply with the relevant requirements of IMO A.658 and marked with the legend:

"**VOYAGE DATA RECORDER – DO NOT OPEN**"

4.3.4.3.3 *The capsule shall be fitted with an appropriate device to aid location*

Both fixed and float free designs shall include an acoustic underwater beacon. In the case of a protective capsule intended for float free operation, it shall also have a suitable radio transmitter, and a light.(see 5.3)

4.3.5 Assessment of recording medium

Where the storage medium cannot be readily and reliably inspected after an incident, means shall be provided to enable an accident investigator to determine, prior to an attempted replay, whether the storage medium has been subjected to an excessive level of heat, where the survival of the stored data may be in doubt.

4.3.6 Interfaces *(A.861/7)*

Interfacing to the various sensors required shall *be in accordance with the relevant international interface standard,* IEC 61162 series, *where possible.* (see annex B)

The VDR shall have at least 16 input (listener) ports conforming to IEC 61162.

The interfaces for bridge audio, communications audio and radar are defined in 5.6.1, 5.7.1 and 5.8.1 respectively.

Any interface units which may be required to convert non-IEC 61162 signals, shall not be considered to be part of the VDR system. However, they shall conform to the requirements of IEC 60945.

In all cases, *any connection to any item of the ship's equipment* shall *be such that the operation of that equipment suffers no deterioration, even if the VDR system develops faults.*

4.4 Data selection and security (A.861/5.1.4)

4.4.1 Selection of data items (A.861/5.2.1)

The minimum selections of operational *data items to be recorded by the VDR are specified in* 4.6. *Optionally, additional items may be recorded provided that the requirements for the recording and storage of the specified selections are not compromised.*

In addition to the operational data referred to in the preceding paragraph, a data block defining the configuration of the VDR and the sensors to which it is connected shall be written into the final recording medium during commissioning of the VDR. This configuration data shall be permanently retained in the final recording medium and protected from modification other than

by a duly authorised person following any change to the configuration. Any change to the configuration of this data block shall not affect the recording of the mandatory items.

The following system configuration information shall be included in this data block:

1. Type approval authority and reference;
2. IMO vessel identification number;
3. Software version(s) used;
4. Microphone locations and recording port allocation;

Note – This does not imply channelization.

5. VHF communications– which VHF(s) recorded;
6. Date and time – from which source obtained;
7. Ship's position – from which EPFS obtained and relative position on the vessel;
8. Other data inputs – identification of which equipment is supplying recorded data; sign conventions and identity of all alarm/door inputs;
9. Automatic insertion of date and time of last amendment.

4.4.2 Resistance to tampering (A.861/5.2.2)

The equipment shall *be so designed that, as far as is practical, it is not possible to tamper with the selection of data being input to the equipment, the data itself nor that which has already been recorded. Any attempt to interfere with the integrity of the data or the recording* shall *be recorded.*

4.4.3 Recording integrity (A.861/5.2.3)

The recording method shall be such that each item of the recorded data is checked for integrity, i.e. it is identical to the data being received, *and an alarm given if a non-correctable error is detected.*

The VDR shall automatically continuously monitor the following (see 6.1.7):

1. Power supply;
2. Record function;
3. Bit error rate;
4. Microphone functionality.

Malfunction of any of the above shall generate an alarm in accordance with the relevant requirements of IMO A.686 at the position from which the vessel is normally navigated. It shall be possible to mute the alarm but a visual indication shall remain until the equipment is serviceable. It shall also indicate its alarm status by means of contacts of a relay (or equivalent) which is held energised in the no-alarm condition.

4.5 Continuity of operation

4.5.1 Operation (A.861/6)

The unit shall *be entirely automatic in normal operation. Means* shall *be provided* to ensure that *the recorded data may be saved by an appropriate method following an incident, with minimal interruption to the recording process* and without requiring opening of the protective capsule.

1. Controls for use during the saving process shall be as simple to use as possible.
2. The recording process to the final recording medium shall not be interrupted for more than 10 min during the saving process. The data recorded in the final recording medium shall not be erased.

3. The saved data shall be automatically checked to ensure that it is identical to the recorded data on the final recording medium. Any failure shall be indicated.
4. When the saving process is completed means shall be provided to enable copies to be made of this or of data relating to subsequent incidents.

4.5.2 Power source (A.861/5.3.1*)*

To ensure that the VDR continues to record events during an incident, it shall *be capable of operating from the ship's emergency source of electrical power.* Whenever electrical power is available the VDR shall operate. (see 6.1.15)

4.5.3 Reserve power source (A.861/5.3.2)

If the ship's emergency source of electrical power supply fails, the VDR shall *continue to record Bridge Audio (see* 4.6.5*) from a dedicated reserve source of power for a period of 2 h. At the end of this period all recording* shall *cease automatically.*

4.5.4 Recording period and duration (A.861/5.3.3)

Recording shall *be continuous unless interrupted briefly in accordance with* 4.5.1 *or terminated in accordance with* 4.5.3. *The time for which all stored data items are retained* shall *be at least 12 h. Data items which are older than this may be overwritten with new data.*

Recording may also be terminated, by means of a key or other secure method, under the following circumstances:

1. For essential maintenance purposes whilst the vessel is in port;
2. When the vessel is laid-up.

4.6 Data items to be recorded (A.861/5.4)

4.6.1 Date and time (A.861/5.4.1)

Date and time referenced to UTC, shall *be obtained from a source external to the ship* (e.g. an electronic position-fixing system (EPFS) or radio time signal) if available, *or from an internal clock* at least once per hour*. The recording* shall *indicate which source is in use. The recording method* shall *be such that the timing of all other recorded data items can be derived on playback with a resolution (sufficient to reconstruct the history of the incident in detail),* not worse than 1 s.

4.6.2 Ship’s position (A.861/5.4.2)

Latitude and longitude, and the datum used, shall *be derived from a* designated *electronic position-fixing system (EPFS) or* integrated navigation system (INS) if available*. The recording* shall *ensure that the identity and status of the* source *can always be determined on playback.* The ship’s position shall be recorded, up to a resolution of 0,0001 min of arc, as available on the ship.

4.6.3 Speed (A.861/5.4.3)

Speed through the water, or speed over the ground (transverse as well as longitudinal in either case, as available on the ship)*, including an indication from which it is derived, from the ship’s* designated *speed and distance measuring equipment,* shall be recorded up to a resolution of 0,1 knot.

4.6.4 Heading (A.861/5.4.4)

As indicated by the ship's compass. The ship’s heading shall be recorded from a designated compass, up to a resolution of 0,1°, as available on the ship.

4.6.5 Bridge audio, (A.861/5.4.5)

One or more microphones shall be *placed on the bridge,* such *that conversation at or near the conning positions, radar displays, chart table etc.*, (i.e. at work stations as defined in 3) may be *adequately recorded. As far as is practicable, the positioning of microphones* shall *also capture* the input and output of *intercom, public address systems and the audible alarms of any bridge mounted equipment.* (see 5.6 for technical characteristics)

The audio signals at all work stations shall be recorded continuously. Optionally, means may be provided so that the originating work station can be identified with the audio signal being analysed during play back of the recorded information.

4.6.6 Communications audio (A.861/5.4.6)

VHF communications relating to ship operations shall *be recorded* independently of the bridge audio. The recording shall include both transmitted and received audio signals and shall be continuous from a directly connected fixed VHF set to be designated at installation. (see 5.7 for technical characteristics)

4.6.7 Radar data, post-display selection (A.861/5.4.7)

This shall *include electronic signal information from within one of the ship's radar installations which records all the information which was actually being presented on the master display of that radar at the time of recording. This* shall *include any range rings or markers, bearing markers, electronic plotting symbols, radar maps, whatever parts of the System Electronic Navigation Chart (SENC) or other electronic chart or map that were selected, the voyage plan, navigational data, navigational alarms and the radar status data that were visible on the display. The recording method* shall *be such that, on playback, it is possible to present a faithful replica of the entire radar display that was on view at the time of recording, albeit within the limitations of any bandwidth compression techniques that are essential to the working of the VDR. (*see 5.8)

4.6.8 Echo sounder (A.861/5.4.8)

This shall *include depth under keel,* up to a resolution of 0,1 m as available on the ship, *The depth scale currently being displayed and other status information* shall be recorded if available.

4.6.9 Main alarms (A.861/5.4.9)

This shall *include the status of all* IMO *mandatory alarms on the bridge.* (see annex C)

4.6.10 Rudder order and response (A.861/5.4.10)

Both *rudder order and response* angles shall be recorded up to a resolution of 1º as available and permitted on the ship. *Status and settings of* heading controller*, if fitted,* shall also be recorded.

4.6.11 Engine order and response (A.861/5.4.11)

This shall *include the positions of any engine telegraphs* or *direct engine/propeller controls,* including shaft(s) rpm (or equivalent), *and feedback indications, if fitted, including ahead/astern indicators. This* shall *also include status of bow* and stern *thrusters if fitted.* RPM shall be recorded up to a resolution of 1 rpm and pitch shall be recorded up to a resolution of 1^{o}.

4.6.12 Hull openings (doors) status (A.861/5.4.12)

This shall *include all* IMO *mandatory status information required to be displayed on the bridge.*

4.6.13 Watertight and fire door status (A.861/5.4.13)

This shall *include all* IMO *mandatory status information required to be displayed on the bridge.*

4.6.14 Accelerations and hull stresses (A.861/5.4.14)

Where a ship is fitted with IMO mandated *hull stress and response monitoring equipment, all the data items that have been pre-selected within that equipment and are available* shall *be recorded.*

4.6.15 Wind speed and direction (A.861/5.4.15)

This shall *be applicable where a ship is fitted with a suitable sensor. Either relative or true wind speed and direction may be recorded, but an indication of which it is* shall *be recorded.*

5 Technical characteristics

5.1 Co-relation in date and time (A.861/5.1.2 & 5.4.1*)*

To ensure that relative timings can be determined within a resolution of 0,1 s, all data items shall, when sampled by the VDR, be recorded with a time index derived from a VDR system clock with an resolution of 0,05 s. The drift of this system clock shall be not more than 1 s in 1 h.

5.2 Particular design requirements for the protective capsule

Where a float free release mechanism is used it shall comply with the relevant requirements of IMO Resolution A 662.

Any float free release mechanism shall be inhibited automatically if the protective capsule has been subjected to a fire temperature more severe than the fire protection of the radio transmission device required by 4.3.4.3.3.

Both float free and fixed designs shall have a release mechanism to facilitate recovery underwater both by a diver or a remotely operated vehicle (ROV). Possible items to be considered are:

1. the use of break away bolts;
2. release levers; or
3. twist lock.

To ensure that the capsule may be retrieved safely after release, suitable large pad eyes or handles should be incorporated.

NOTE – It should be borne in mind that the manipulator jaws of typical underwater recovery machines have a maximum opening of only 300 mm, a gripping force limit of about 1 kN, and a pulling force limit of about 500 N.

5.3 Location beacon(s) for the protective capsule

These shall include an acoustic underwater beacon operating in the frequency band of 25 kHz to 50 kHz with a battery life of at least 30 days, which shall meet SAE AS 8045.

In the case of a protective capsule intended for float free operation, it shall also have a suitable radio transmitter, complying with appropriate international resolutions and recommendations, to transmit signals suitable for location purposes, for example, IMO A.810, IMO A.812, ITU-R M.632 and ITU-R M.633. It shall also have a light conforming to the appropriate requirements of IMO A.689. The battery life for both the radio and light functions shall be at least 7 days.

The buoyancy characteristics of a float free protective capsule shall ensure that the radio antenna will radiate an essentially hemispherical and vertically polarised signal. The float free protective capsule shall be designed such that a usable signal is provided in, at least, open sea-state 7. (equivalent to Beaufort wind-scale 10)

5.4 Survivability of recorded data

5.4.1 Long term retention under normal conditions

The final recording medium shall retain the recorded data for a period of at least two years, following termination of recording, under operational and storage conditions specified by the equipment manufacturer. Consideration should be given to the distribution of data within the recording medium.

5.4.2 Survival following an incident

The capsule shall be designed to ensure that the data held in the final recording medium, shall be retrieved without loss after it has been subjected to the following conditions:

.1 Shock

A half sine wave pulse of 50 g, with a duration of 11 ms, as specified in section 11 of Part 2 of IEC 68-2-27.

.2 Penetration

A mass of 250 kg with a pin of 100 mm diameter, dropped from a height of 3 m, as specified in 5.3.2b of ED 56A.

.3 Fire

A low temperature fire of 260^{o} C nominal for ten hours, as specified in 5.3.2e of ED56A.

.4 Deep sea pressure and immersion

Immersion in sea water at a pressure of 60 MPa (equivalent to a depth of 6 000 m), as specified in 5.3.2f of ED 56A.

5.5 Information to be included in the manufacturer's documentation

5.5.1 Installation guidelines

1. Siting of the protective capsule;

The protective capsule should be sited in the vicinity of the bridge on the external deck area of the vessel so as to maximise the probability of its survival and recovery following an incident. The capsule should be positioned clear of rigging and other potential obstructions and as near to the centre line of the ship as practically possible.

Criteria to be considered when assessing the optimum position should include but not be limited to the following:

a) Separation from fuel or other potential fire sources.

b) Separation from probable sources of mechanical damage.

c) Operational environment for continued serviceability

d) Accessibility for copying of recorded data and for routine maintenance.

e) Facilitation of underwater removal and retrieval by both divers and ROVs. There should be a clear unobstructed space in the vicinity of the capsule to allow an ROV or diver to work.

f) In the case of float free configuration, minimisation of the risk of obstruction after release.

2. Siting of microphones;

3. Siting of all other components of the VDR configuration;

4. Entering and updating the static configuration data of 4.4.1;

5. The requirement for interface units to comply with 4.3.6.

5.5.2 Operation and maintenance manual

The manual shall include the following:

.1 Instructions on normal operation of the VDR;

.2 Instructions on how to copy data from the equipment;

.3 Instructions on the action to be taken following the activation of any VDR alarm;

.4 Instructions for downloading and verification of the final recording medium data. These should be carried out whenever maintenance or repair has been carried out on any sensor or on the VDR itself, or at least annually;

.5 Maintenance tasks required to ensure the serviceability and continued seaworthiness of the VDR. An analysis shall be performed by the equipment installer to identify those sensors or transducers where the serviceability or accuracy could be degraded and remain undetected. The maintenance tasks to be performed shall take account of this analysis by requiring appropriate functional and calibration checks at suitable intervals.

5.5.3 Information for use by an investigation authority

The following shall be available:

.1 Instructions to enable an investigation authority to manufacture any special tools or interface equipment required for retrieval of recorded data from the recorder;

.2 Details of the necessary actions to be followed for data retrieval from an undamaged protective capsule;

.3 Details of the necessary actions to be followed for data retrieval from a protective capsule that has been damaged in an incident;

.4 Details of software required to enable playback of recorded data.

5.6 Bridge audio specifications

5.6.1 Input interface

The microphones forming the bridge audio data source are to be considered to be parts of the VDR. The form of the connections, signal levels and impedances, are at the option of the manufacturer. However, for the purposes of testing, each microphone shall be connected via a plug / socket combination, which is referred to hereafter as an **input port**.

5.6.2 Reference signal

The manufacturer shall declare a reference signal, for each microphone input, at the electrical input port of the VDR. This shall be defined as a 1 kHz sinusoid at the maximum level for which the equipment is designed to meet this performance specification.

5.6.3 Audio frequency response

Signal levels of both 6 dB and 45 dB below the reference signal level, shall be applied to every bridge area microphone input port in turn, With the frequency swept continuously at a rate not exceeding 0,1 octaves per second, over the range of 150 Hz to 6 000 Hz, the level of signal recovered from the VDR shall not vary by more than a total range of 6 dB, on playback. Any other microphone input ports shall have no signals applied at this time.

5.6.4 Quality index

The quality of the recording shall be established for single and multiple microphone inputs.

5.6.4.1 Single microphone

The quality of the recording for each of the bridge area microphone ports shall be established at the electrical equivalent level of 75 dBA. This shall not be less than that corresponding to the quality value for the speech transmission index of 0,85 (see IEC 268-16), with no signal being simultaneously applied to other microphone ports.

5.6.4.2 Multiple microphones

The quality of the recording for each of the bridge area microphone ports shall be established at the electrical equivalent level of 75 dBA. This shall not be less than that corresponding to the quality value for the speech transmission index of 0,60 (see IEC 268-16) with all of the other microphone ports having inputs at the electrically equivalent level of 65 dBA.

5.6.4.3 Audio noise level – signal to no signal

With no signal applied to any bridge area microphone port, the reproduced signal at any replay output shall be at least 48 dB below the output level, which would be produced by an input level equal to the reference signal level. This requirement shall be met across the frequency band as defined in 5.6.3 with the inputs both open and short circuited. The above signal to no signal performance shall be met in the presence of out-of-band input signals and also at the reference signal level.

5.6.5 Audio noise level – signal to noise and distortion

With all other input ports, except the one in use, short circuited, the reproduced signal to noise and distortion (SINAD) ratio shall be at least 24 dB across the frequency band as defined in 5.6.3 and with input levels in the range of 0 dB to – 20dB relative to the reference signal level for all input ports.

5.7 Communications audio

5.7.1 Input interfaces

The audio connection with the designated VHF equipment shall be in accordance with the requirements of IEC 61097-7. For the purposes of testing, the connection shall be via a plug /socket combination referred to hereafter as the **input port**.

Additionally, the status of the designated VHF equipment, as available on the ship in the appropriate IEC 61162 format, shall be recorded.

5.7.2 Reference signal

The reference signal level for both transmitted and received communications audio is defined as 0 dBm into 600 Ω. If an extension interface into the VDR is required it shall provide a 0 dBm output at its maximum input level.

5.7.3 Audio frequency response.

With a signal level 6 dB below the reference signal level applied to the VHF radio communications input port of the VDR and with its frequency continuously swept at a rate not exceeding 0,1 octaves per second over the range of 150 Hz to 3 500 Hz, the level of the signal recovered from the VDR on playback shall not vary by more than 6 dB.

5.7.4 Quality index

The quality of the recording for the VHF radio communications port shall be established and shall not be less than that corresponding to the quality value for the speech transmission index of 0,75. (see IEC 268-16)

5.7.5 Audio noise level – signal to no signal

With no signal applied to a VHF radio communications port, the reproduced signal shall be at least 48 dB below the output level produced by an input equal to the reference signal level. This requirement shall be met across the frequency band as defined in 5.7.3 with the input port both open and short circuited. The above signal to no signal performance shall be met in the presence of out-of-band input signals and also at the reference signal level.

5.7.6 Audio noise level – signal to noise and distortion (SINAD)

The reproduced SINAD ratio shall be at least 24 dB across the frequency band as defined in 5.7.3 and with input levels in the range of 0 dB to – 20 dB relative to the reference signal level.

5.8 Radar data – post-display selection

5.8.1 Input interface

5.8.1.1 Source and acquisition

The VDR shall be capable of being connected to a buffered video output from the radar display whose image it is to record.

The VDR shall record a series of single and complete screen video frames from the dedicated buffered output port of the radar. One complete radar screen video frame shall be acquired at intervals of 15 s or less.

Additionally, the status of the designated radar equipment, as available on the ship in the appropriate IEC 61162 format, shall be recorded.

5.8.1.2 Mandatory image input format

The VDR shall meet fully the requirements of 6.2.4 with buffered outputs meeting the electrical specifications of VESA DMTS, where that standard refers to display monitors having screen resolutions between 640 × 350 and 1280 ×1024 and refresh rates between 60 Hz and 85 Hz.

5.8.1.3 Optional image input format

Optionally the VDR may operate with other forms of buffered outputs that have been defined by an individual radar manufacturer.

5.8.2 Image outputs

5.8.2.1 Format and resolution.

When used with playback equipment specified by the manufacturer, the resolution of the output image shall be equal to or greater than the resolution of the image input. The specified playback equipment shall have an output meeting VESA DMTS, and a digital output meeting the requirements of 6.2.4.2.

5.8.2.2 Fidelity

The recording shall be subjectively lossless, as determined by the objective tests described in 6.2.4.1 to 6.2.4.6. In addition to those objective tests, the screen display on the playback equipment shall be a subjectively satisfactory facsimile of the original display as determined by the test described in 6.2.4.7.

6 Methods of testing and required test results

6.1 General

6.1.1 Definition of equipment under test (EUT)

In this section, except where specifically stated otherwise, any reference to the equipment under test (EUT) shall be interpreted as comprising all the parts of a shipborne VDR configuration including:

.1 IEC 61162 listener port(s);

.2 microphone(s) and associated self-test device;

.3 communications audio input(s) unit;

.4 radar video input unit;

.5 control and display unit(s);

.6 the final recording medium in its protective capsule;

.7 power supply unit(s);

.8 all other item(s) declared by the manufacturer;

.9 manufacturer's documentation.

The EUT shall be installed in the test facility using interconnection and input cabling and methods representative of a normal installation, but this material and installation shall not be considered part of the EUT.

6.1.2 Playback equipment

The manufacturer shall demonstrate to the satisfaction of the testing authority that the data from the final recording medium can be reproduced following the required tests. The playback equipment is not to be considered as part of the EUT, although the relevant documentation shall be included.

6.1.3 Sequence of tests

Except where specifically stated otherwise, the tests shall all be conducted on a single EUT but may be performed in any sequence agreed between the manufacturer and the test authority.

6.1.4 Requirements to be checked by inspection only

The testing authority shall check, by examination of the EUT and manufacturing and other documentation to be provided by the manufacturer, compliance with the requirements of the following:

.1 Tamper resistance – 4.3.3, 4.3.4 and 4.4.2;

Particular reference shall be made to the following:

a) Access to any part of the system shall require the use of tools or keys;

b) Operation of any controls or keyboard keys, or any combination of these, shall not affect recording;

c) Termination of recording shall only be possible by means of a key or other secure method.

d) Recorded data shall be protected against unauthorised access by use of a password.

.2 Marking (see 4.3.3.4.2);

.3 Location devices (see 4.3.3.3, 5.3);

.4 Power source (see 4.5.2);

.5 Documentation (see 5.5).

6.1.5 Environmental test conditions for normal operation

The special conditions and tests for survival of data after an incident are in 6.1.13.

The manufacturer shall determine which components of the VDR system are in which class, and in which EMC category, as defined in IEC 60945.

The equipment shall be tested in accordance with 6.1.6 to 6.1.12 inclusive, to confirm that it performs its intended function when operating in the environmental conditions specified in IEC 60945.

It is important to ensure, either by test in the EUT or separately, that the battery of the dedicated reserve power source meets the requirements of 4.5.3 and 6.1.7 at the extreme operating temperatures specified in IEC 60945.

6.1.6 Recording duration

6.1.6.1 Test method

The equipment shall operate continuously using normal external electrical power, recording suitable test signals for a duration in excess of 12 h. Test data streams for the audio and radar inputs shall be chosen to fully exercise the data processing methods.

NOTE – This test may be combined with the test of 6.1.7.

6.1.6.2 Required results

Recording shall be continuous in compliance with the requirements of the appropriate sub-clauses of 4.5.

6.1.7 Reserve power source

6.1.7.1 Test method

Whilst operating using normal external electrical power, the power shall be removed for a period in excess of 2 h. The EUT shall continue to operate in accordance with 4.5.3. During a period of 2 h the maximum number of microphones the VDR can accommodate shall be powered by the dedicated reserve power source. During this test the area in which the microphones are installed shall be subjected to speech and sounds typical of those on a ship's bridge. The normal external electrical power shall then be restored.

6.1.7.2 Required result

A suitable alarm shall be generated. As an exception to normal alarm requirements, the audible alarm shall be at a low enough level to permit other sounds on the bridge to be heard clearly on playback. Also, to conserve battery power, it shall be muted automatically after 2 min, if it has not been acknowledged in that period.

The EUT shall continue to operate from its reserve source of power for 2 h and shall then terminate automatically in accordance with 4.5.3.

After normal external electrical power has been restored it shall be demonstrated that:

.1 the VDR resumes normal operation;

.2 ten hours of recording have been retained, prior to the power interruption, followed by 2 hours of recording of only bridge audio.

6.1.8 Recharging of reserve source of power

6.1.8.1 Test method

On completion of the test of 6.1.7, normal external electrical power supply shall be maintained for a continuous period of 10 h. Test 6.1.7 shall then be repeated.

6.1.8.2 6.1.8.2 Required results

It shall be demonstrated that the reserve source of power was recharged sufficiently to operate the equipment for 2 h.

6.1.9 Brief interruption of electrical power

6.1.9.1 Test method

The test of 6.1.7.1 shall be repeated and normal external electrical power shall be restored after a period of 3 min.

6.1.9.2 Required results

The alarm behaviour of 6.1.7.2 shall occur. After normal external electrical power has been restored it shall then be demonstrated that:

.1 the VDR resumes normal operation.;

.2 At least 11 h 50 min of recording have been retained prior to the power interruption ;

.3 recording of bridge audio continued during the power interruption.

6.1.10 System integrity

For each of the following it shall be demonstrated that a suitable alarm is activated:

.1 Power supply

Whilst operating using normal external electrical power, this power shall be removed.

NOTE – This test is included in the tests of 6.1.7, 6.1.8 and 6.1.9.

.2 Record function, bit error rate;

The manufacturer shall demonstrate that if the test data signals (radar, audio and data) are not being correctly recorded on the final recording medium, a suitable alarm is activated. The bit error rate for digital signals shall exceed 1 in 10^8;

NOTE – to avoid the need to create an actual fault condition in the EUT, it is acceptable for this to be checked by examination of documentation.

.3 Microphone functionality

The manufacturer shall demonstrate that at least once every 12 h there is an unobtrusive acoustic test of all microphones. A suitable alarm shall be activated if any of these tests fail.

6.1.11 Maintenance of sequential records

The manufacturer shall demonstrate that the VDR maintains sequential records as required by 4.3.2.

6.1.12 Time co-relation

6.1.12.1 Test method

The VDR shall record a 30 min series of data input events to fully exercise the requirements of 4.3.3 and 5.1. This recorded data shall be replayed.

6.1.12.2 Required result

The time indices of the replayed data shall meet the requirements of 4.3.3 and 5.1.

6.1.13 Design and construction of the protective capsule

6.1.13.1 Definition of EUT for 6.1.13

For these tests only, any reference to “the EUT” shall mean:

.1 the sealed capsule shell(s), complete with all internal fittings, linings, heat insulators;

.2 the final recording medium, as normally installed inside the capsule;

.3 any power supply units or batteries that normally form part of the capsule contents;

.4 all mounting hardware and release mechanism(s), including the automatic release mechanism in the case of a float-free design;

.5 the acoustic beacon or a mechanically equivalent dummy;

.6 the normal electrical or other cable through which data is transferred between the main units of the VDR and the final recording medium during normal operation.

6.1.13.2 Test data to be pre-loaded into the final recording medium

In accordance with manufacturer’s instructions, a test data set shall be recorded into the recording medium of the EUT so as to utilise all available memory. An exact copy of the test data set shall be retained for comparison purposes.

6.1.13.3 Tests and test sequence

The EUT shall be subjected to the tests of 6.1.13.4 to 6.1.13.8 inclusive, in the order listed.

.1 shock;

.2 penetration;

.3 fire;

.4 sea water immersion to test the release mechanism for a float-free design only;

.5 deep sea immersion.

These tests shall be normally carried out on a single EUT. As a minimum, the fire test, the seawater immersion test (where applicable) and the deep sea immersion tests shall be conducted on the same EUT. However, it is not a mandatory requirement that a single EUT shall survive the other tests in addition to these.

The deep sea immersion test may be omitted if it can be proved that the final recording medium can withstand the conditions associated with deep sea immersion and that the data in it will not be damaged as a consequence of the collapse of the protective capsule.

6.1.13.4 Shock

The EUT shall be secured to the test rig in accordance with the manufacturer’s normal installation instructions.

It shall then be subjected to the test requirements of section 11 of Part 2 of IEC 68-2-27, with the following parameters:

a) Pulse shape – half sine;

b) Tolerances – as figure 2;

c) Velocity change special case – not applicable;

d) Transverse motion – not applicable;

e) Method of mounting – fastened to the testing machine or table using the normal shipboard installation mounting arrangements specified by the manufacturer;

f) Peak acceleration – 50g, duration of the nominal pulse 11ms;

g) Pre conditioning – nil;

h) Initial measurements (see 6.1.3);

i) Direction and number of shocks – standard;

j) Survive the conditions of shock;

k) Acceptance and rejection criteria;

l) Not applicable;

m) Not applicable;

n) Not applicable.

6.1.13.5 Penetration

The EUT shall be secured to the test rig in accordance with the manufacturer's normal installation instructions.

The protective capsule shall be subjected to the requirements of 5.3.2b of ED56A. The mass used shall be 250 kg, with a pin diameter of 100 mm, dropped from a height of 1 m.

6.1.13.6 Fire

The protective capsule shall be subjected for ten hours at 260^0 C, to the requirements of 5.3.2e of ED56A – amendment 1.

NOTE – If an actual acoustic beacon is used during the test, caution must be exercised due to possible explosion of the battery.

6.1.13.7 Shallow sea water immersion

This test is applicable only to capsules designed to float-free. The float free release mechanism shall be tested for compliance with the appropriate requirements of IMO A.662. It shall be demonstrated that the float free mechanism is inhibited if the fire exceeds the fire survivability of the radio transmission device as in 4.3.4.3.1.

6.1.13.8 Deep sea immersion

The protective capsule shall be subjected to the requirements of 5.3.2f of ED56A. Both the 6 000 m 24 hour test described in paragraph 1 and the 3 m 30 day test described in paragraph 2 shall be carried out.

6.1.13.9 Required results of 6.1.13.4 to 6.1.13.8

After completion of the test sequences, all the release mechanisms shall function according to the appropriate specifications. Repairs shall not be permitted.

After completion of the tests, the stored data shall be retrieved following the manufacturer's instructions, which may include error correcting. No repairs to the final recording medium shall be permitted. For the purposes of playback, the final recording medium may be removed from the EUT and installed into standard replay equipment as supplied by the recorder manufacturer. A comparison shall be made of the stored data and the retained copy. Thermal, mechanical or corrosive damage to the recording medium incurred during the test that results in the loss of data, shall constitute a failure.

The under water locator beacon need not survive the fire tests, but shall remain attached to the protective capsule throughout.

6.1.13.10 Aid(s) to location

The acoustic beacon shall be tested for compliance with SAE AS 8045.

If the capsule is designed for float-free operation, the radio transmitter and light shall be tested for compliance to the appropriate parts of IEC 61097-2, IEC 61097-5 and IMO A.689 (see also 5.3), but with a required duration of 7 days.

6.1.14 Data selection

The manufacturer shall demonstrate that the configuration data specified in 4.4.1 can be entered, maintained and retrieved.

6.1.15 Power source

It shall be confirmed that the VDR operates at all times when electrical power is applied.

6.2 Data items to be recorded

6.2.1 Date/time – ship's position – speed – heading (A.861/5.4.1 – 5.4.4)

6.2.1.1 Test method

The test method and result required are the same for these four parameters.

Present the date/time, ship's position, speed and heading data, one at a time, conforming to the format specified in 5.8 to the port designated for the relevant parameter. The data shall be presented at a rate greater than once per second and changed at a rate less than once per second. Record the data for 30 min. Replay the data.

6.2.1.2 Result required

All the changed data shall be accurately reproduced at a rate of at least once per second.

6.2.2 Bridge audio (A.861/5.4.5)

6.2.2.1 Audio frequency response for bridge audio

6.2.2.1.1 Test method

The following test equipment is required:

.1 Sweep frequency audio signal generator;

.2 Audio power meter;

.3 Frequency counter.

With all other area microphone port inputs short circuited, connect the audio signal generator to the port under test and adjust its output to obtain a signal capable of continuously sweeping over the frequency range. Adjust the sweep frequency rate to 0,1 octave per second. Set the level to 6 dB below the reference signal level at the equipment input. Record this signal.

Replay the recording and measure the output level and frequency. Determine the level variation over the frequency band. Repeat for all other area microphone ports.

Repeat the tests with the input set at 45 dB below the reference level.

6.2.2.1.2 Result required

The test results shall meet the requirements of 5.6.3.

6.2.2.2 Quality index for bridge audio

6.2.2.2.1 Single port

6.2.2.2.2 Test method

The following test equipment is required:

.1 STI signal generator;

.2 STI analyser;

.3 White noise generator;

.4 Audio band-pass filter (150 Hz to 6 000 Hz).

With all other area microphone port inputs short circuited, connect the signal generator to the port under test. Adjust the signal generator to a level equivalent to 75 dBA. Record the signal.

Replay the recording and analyse the STI. Repeat for all other area microphone ports.

6.2.2.2.3 Result required

The test results shall meet the requirements of 5.6.4.1.

6.2.2.3 Multiple ports

6.2.2.3.1 Test method

With all other area microphone ports having an electrical input equivalent to 65 dBA of band limited white noise, connect the signal generator to the port under test. Adjust the signal generator to level equivalent to 75 dBA. Record the signal.

Replay the recording and analyse the result. Repeat for all other area microphone ports.

6.2.2.3.2 Result required

The test results shall meet the requirements of 5.6.4.2.

6.2.2.4 Audio noise level – signal to no signal for bridge audio

6.2.2.4.1 Test method

The following test equipment is required:

1. Audio signal generator;
2. A-weighted filter to IEC 651;
3. Third octave filters to IEC 61260 ;
4. Audio power meter.

With all other area microphone port inputs short circuited, connect the audio signal generator to the port under test. Record the signal.

Operate the recorder for 30 s for each of the following five input conditions, open, shorted, and with three separate out-of-band signals applied. For the out-of-band tests, connect the signal generator to each port under test and set the input signal to the reference signal level. Select, in turn, frequencies of 8 kHz, 10 kHz and 12,5 kHz. Replay the recordings measuring the A-weighted noise level in the 3rd octave bands. Table 1 is an example for entering this data. Enter the noise level in the 3rd octave bands as a ratio relative to the output for the reference signal input, expressed in dB. Record the lowest value in the last row of the table. Repeat the test for the other area microphone ports.

6.2.2.4.2 Result required

The test results shall meet the requirements of 5.6.4.3.

Reference level: _____

Centre frequency of third octave band (Hz)	Output A-weighted level relative to reference level (dB)				
			Out of band @ reference level		
	Open	Shorted	8 000 Hz	10 000 Hz	12 500 Hz
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 150					
4 000					
5 000					
Minimum signal to no-signal ratio =					

Table 1 – Bridge audio, signal to no-signal measurements

6.2.2.5 Audio noise level – signal to noise and distortion for bridge audio

6.2.2.5.1 Test method

The following test equipment is required

1. Attenuator;
2. Band-pass filter;
3. Distortion meter.

With the other area microphone ports short circuited, connect the port under test via an attenuator to the signal source of the distortion meter and record signals at 3rd octave intervals over the band varying the level from the reference level to – 20 dB in 5 dB steps recording the signal at each step. Replay the recordings and measure the total harmonic distortion plus noise for each test condition. Table 2 is an example for entering this data. Optionally, the measurement may be made after passing the replayed signal through a band-pass filter of 150 Hz to 6 000 Hz. Enter the distortion plus noise as a power ratio, expressed in dB. Record the lowest value in the last row of the table. Repeat the test for the other area microphone port.

6.2.2.5.2 Result required

The test results shall meet the requirements of 5.7.6.

Reference level: _____

Frequency (Hz)	Input relative to reference level				
	0 dB	**-5 dB**	**-10 dB**	**-15 dB**	**-20 dB**
150					
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 150					
4 000					
5 000					
Minimum signal to noise and distortion ratio =					

Table 2 – Bridge audio, signal to noise and distortion (SINAD) measurements

6.2.3 Communications audio (A.861/5.4.6)

6.2.3.1 Audio frequency response for communications audio

6.2.3.1.1 Test method

The following test equipment is required:

1. Sweep frequency audio signal generator;
2. Audio power meter;
3. Frequency counter.

Connect the audio signal generator to the port under test and adjust its output to obtain a signal which continuously sweeps over the frequency range. Adjust the sweep frequency rate to 0,1 octave per second. Set the level to 6 dB below the reference signal level at the equipment input. Record this signal.

Replay the recording and measure the output level and frequency. Determine the level variation over the frequency band.

6.2.3.1.2 Result required

The test results shall meet the requirements of 5.7.3.

6.2.3.2 Quality index for communications audio

6.2.3.2.1 Test method

The following test equipment is required:

1. STI signal generator;
2. STI analyser.

Connect the STI signal generator to the port under test. Adjust the STI signal generator to a level 6 dB below the reference level. Record the signal.

Replay the recording and analyse the STI.

6.2.3.2.2 Result required

The test results shall meet the requirements of 5.7.4.

6.2.3.3 Audio noise level – signal to no signal for the communications audio

6.2.3.3.1 Test method

The following test equipment is required;

1. Audio signal generator;
2. A-weighted filter to IEC 651;
3. Third octave filters to IEC 61260;
4. Audio power meter.

Connect the audio signal generator to the port under test. Record the signal. Operate the recorder for 30 s for each of the following five input conditions: open, shorted, and with three separate out-of-band signals applied. For the out-of-band tests, connect the signal generator to each port under test and set the input signal to the reference signal level. Select, in turn,

frequencies of 5 kHz, 6,3 kHz and 8 kHz. Replay the recordings measuring the A-weighted noise level in the 3rd octave bands. Table 3 is an example for entering this data. Enter the noise level in the third octave bands as a ratio relative to the output for the reference signal input, expressed in dB. Record the lowest value in the last row of the table.

6.2.3.3.2 Result required

The test results shall meet the requirements of 5.7.5.

Reference level: _____

Centre frequency of third octave Band (Hz)	**Output A-weighted level relative to reference level dB**				
	Open	**Shorted**	**Out of band @ reference level**		
			5 000 Hz	**6 300 Hz**	**8 000 Hz**
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 150					
Minimum signal to no-signal ratio =					

Table 3 – Communications audio, signal to no-signal measurements

6.2.3.4 Audio noise level-signal to noise and distortion for communications audio

6.2.3.4.1 Test method

The following test equipment is required:

1. Attenuator;
2. Band-pass filter;
3. Distortion meter.

Connect the port under test via an attenuator to the signal source of the distortion meter and record signals at 3rd octave intervals over the band varying the level from the reference level to – 20 dB in 5 dB steps recording the signal at each step. Replay the recordings and measure total harmonic distortion plus noise for each test condition. Table 4 is an example for entering this data. Optionally the measurement may be made after passing the replayed signal through a band-pass filter of 150 to 3 500 Hz. Enter the distortion plus noise as a power ratio, expressed in dB. Record the lowest value in the last row of the table.

6.2.3.4.2 Result required

The test results shall meet the requirements of 5.7.6.

Reference level: _____

Frequency Hz	Input relative to reference level				
	0 dB	-5 dB	-10 dB	-15 dB	-20 dB
150					
200					
250					
315					
400					
500					
630					
800					
1 000					
1 250					
1 600					
2 000					
2 500					
3 500					
Minimum signal to noise and distortion ratio =					

Table 4 – Communications audio, signal to noise and distortion (SINAD) measurements

6.2.4 Radar data, post-display selection (A.861/5.4.7)

6.2.4.1 Test objective

The tests outlined in the sub-clauses of 6.2.4 determine that the VDR meets the functional requirements of 4.6.7. They measure errors between input images, generated from a pre-determined test data set, and the output of a VDR that has recorded them. Recognising that, with currently available 'final storage media', the VDR must first acquire and digitise an image before it can store it, two different categories of errors are considered:

1. colour errors, where a feature is rendered in a different colour or brightness on the input image compared to the output image; and
2. positional errors, where an image feature is in a different position on the input image compared to the output image

With regard to colour, the general aim is to permit only those errors that, ideally, a human observer would not notice and which, necessarily, could not introduce ambiguity.

With regard to position, small scaling errors are permitted if the linearity is good: for example, a small overall increase in the size of the image is acceptable, but a scaling of similar magnitude which varies over the image is not. For this reason, a linearity measure is applied in various ways to assess the acceptability of the errors that occur.

The definitions below are for the purposes only of 6.2.4.2 to 6.2.4.6 inclusive.

colour
a triple of real values (*r,g,b*) specifying amounts of red, green and blue respectively, where $0 \le r \le 1$, $0 \le g \le 1$ and $0 \le b \le 1$. As such 'colour' includes both hue and intensity.

image

a function which defines a colour for each value of a pair of real numbers (*x,y*) representing Cartesian co-ordinates, where $0 \le x \le 1$ and $0 \le y \le 1$.

pixel
a rectangular region of an image where the colour of the image is constant. The region is defined by two pairs (x_0,y_0) and (x_1,y_1) representing the Cartesian co-ordinates of diagonally opposite corners of the rectangle. The sides of the rectangle shall be parallel to the Cartesian axes and $x_0 < x_1$ and $y_0 < y_1$.

input image
one of a number of pre-determined test images, see 6.2.4.4. The test images are defined mathematically and are made up of a grid of pixels of various colours.

input image resolution
the integers X and Y that represent respectively the numbers of pixels on the x and y co-ordinates of the input image(s) with which the VDR manufacturer declares the VDR will operate.

output image
the image that is produced by the playback equipment when a recording of the original image is played back.

bit mapped image
an image composed entirely of pixels and for each pixel, the products Xx_0, Yy_0, Xx_1 and Yy_1 are integers.

6.2.4.2 The principles of the test

The manufacturer shall declare at what *X,Y* resolutions of input images, specified in 5.8.1.2 and with which optional inputs, permitted by 5.8.1.3, the VDR is designed to operate. All the test equipment shall operate at sufficiently high resolutions. The EUT is connected as shown in figure 1.

A test data set (A), representing a pre-determined, bit-mapped, test image is loaded into the input image store (B). That store is then read via an interface that includes a digital to analogue converter (C) that, in its turn, provides two mandatory output signals and one optional one.

Signals (S1) and (S2) are identical.

Signal (S1) shall meet the VESA DMTS and drives a monitor (D) that has been approved to the same standard.

Signal (S2) provides the input image to the EUT (E) and shall satisfy the requirements of 5.8.1.2.

Signal (S3) is any signal, optionally chosen by the VDR manufacturer, in accordance with 5.8.1.3, as an input to the EUT (E).

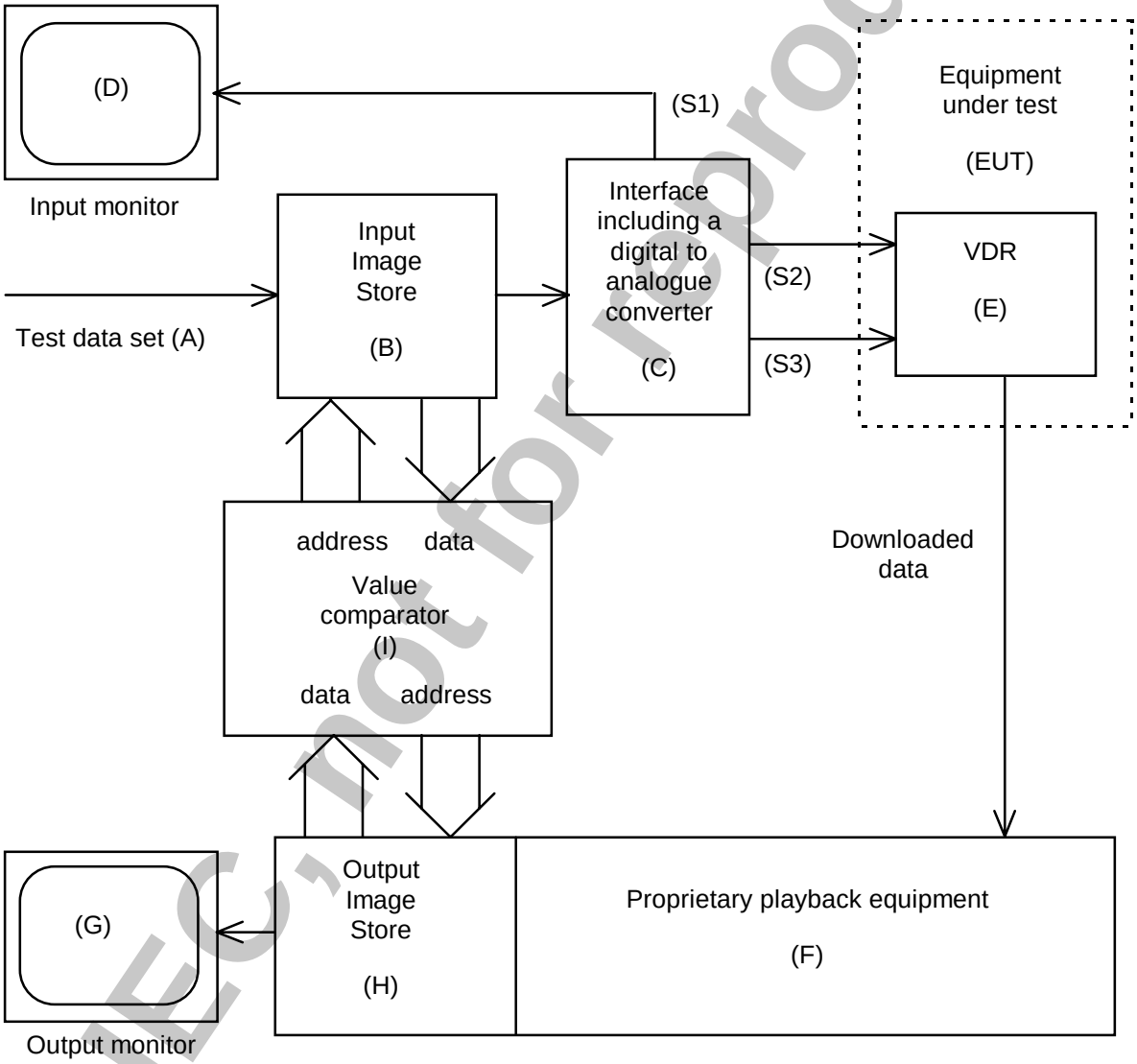

Figure 1 – Test set-up block diagram

During the test, the detailed timings of the video signals shall be varied within the limits allowed by the DMTS and by the additional limits required by 5.8.1.2. Where a VDR manufacturer additionally opts to connect to an input image permitted by 5.8.1.3, the timings shall be varied within the limits specified by the radar manufacturer.

The data stored in the final recording medium that relates to the recorded image shall be recovered by a means specified or supplied by the manufacturer as required by 4.3.4.2 and provided as an input to a playback equipment (F) that is also specified or supplied by the manufacturer. That playback equipment shall have two outputs. The first is a video signal meeting the DMTS that is connected to a monitor (G): the second is the digital data from an externally addressed output image store (H) which may be virtual or real.

The essence of the test is that the value comparator (I) obtains the red, green and blue values of some pixel, at an integer address *xX,yY*, from the input image store (B), and requests the value from output image store (H) for the same address. This is done for every pixel in the input image store.

The contents of the two image stores are divided into small rectangles that are compared individually. The positions of corresponding rectangles in the two images can be shifted slightly relative to one another before comparison to allow for a certain amount of alignment error in the recorded images. The amount of shift is permitted to vary slightly over the image to allow for various non-linearities. Any shift shall be of the whole rectangle and of every address, corresponding to an input image pixel that it contains. Linearity is assessed separately in the *x* and *y* directions by considering individually the rows and columns of rectangles.

6.2.4.3 Comparison of images

NOTE – Reference should be made to figure 2.

Errors in colour and position are determined separately: both are defined in terms of differences between the input digital image store (B) and the output digital image store (H). For analytical convenience and to make the test method independent of image resolution, pixel co-ordinates and the amplitudes of the analogue signals representing the values of red (*r*), green (*g*) and blue (*b*) signals are normalised prior to comparison by dividing their actual value by their maximum one.

For example, $r = r_{actual} \div R,\ \ 0 \le r_{actual} \le R,\ \ x = x_{actual} \div X,\ \ 0 \le x_{actual} \le X$ etc

All of the tests described in 6.2.4.4 and 6.2.4.5 shall be passed for each of the images in the test set defined in 6.2.4.2.

The *x* and *y* axes of the input image are each divided into integer *n* equal parts, where *n*=8.

NOTE – To assist comprehension, reference is made in the following text to variable *n,* although its value is fixed at 8.

Thus the whole image is divided into n^2 rectangles indexed by two integer variables *j* and *k*, where $0 \le j \le n\text{-}1$ and $0 \le k \le n\text{-}1$. Rectangle (*j,k*) has diagonally opposite corners at co-ordinates (*j/n,k/n*) and ((*j* + 1)/*n*,(*k* + 1)/*n*), and has its edges parallel to the Cartesian axes.

For each rectangle (*j,k*) a corresponding and equally sized rectangle is chosen in the output image, as specified by the manufacturer. That rectangle has its diagonally opposite corners at real co-ordinates ($p_{jk}/n, q_{jk}/n$) and ((p_{jk} + 1)/*n*,(q_{jk} + 1)/*n*), where $0 \le p_{jk} \le n\text{-}1$ and $0 \le q_{jk} \le n\text{-}1$: its edges are parallel to the Cartesian axes. The correspondence between rectangles in the input and output images may be chosen afresh for each rectangle but shall remain constant for each test image. Figure 2 illustrates four of the 64 rectangles, with indicative displacements of the output, for the case when *X* = 1280 and *Y* = 1024.

6.2.4.4 Pre-determined test images

There are three test images that are specifically designed to work with the test method 6.2.4.3 so as to allow it to satisfy the test objective 6.2.4.1. As such, they are not suitable for use as part of any other test within this specification.

It is required that all of the tests of 6.2.4.4 and 6.2.4.5 shall be passed on test images 1, 2, and on at least three examples of test image 3.

6.2.4.4.1 Test image 1

This shall consist of overlaid horizontal and vertical bands of red (*r*=1, *g*=0, *b*=0), green (*r*=0, *g*=1, *b*=0,), blue (*r*=0, *g*=0, *b*=1,) and black (*r*=0, *g*=0, *b*=0). The colours of the bands shall be a repeating sequence of red, fixed-width black, green, fixed-width black, blue and variable-width black. The intersections between the horizontal and vertical bands shall comply with the table 5.

Vertical / Horizontal	**red**	**green**	**blue**	**black**
red	red	green	Blue	red
green	red	green	Blue	green
blue	red	green	Blue	blue
black	red	green	Blue	black

Table 5 – Intersection colours of test images 1 and 2

The red, green, blue and fixed-width black bands shall be one pixel wide and the variable-width black bands shall have widths that change over the image.

The widths of the vertical variable-width black bands shall be the smallest integer that is greater than the value of the expression $0,5 + |\sin(2\pi x/X) \bullet X/20|$ where x is the x co-ordinate of the leftmost edge of the band. The widths of the horizontal variable-width black bands shall be the smallest integer that is greater than the value of the expression $0,5 + |\sin(2\pi y/Y) \bullet Y/15|$ where y is the y co-ordinate of the topmost edge of the band.

6.2.4.4.2 Test image 2

This shall be identical to test image 1 except that the expressions for the widths of the vertical and horizontal variable-width black bands shall be $0,5 + |\cos(2\pi x/X) \bullet X/20|$ and $0,5 + |\cos(2\pi y/Y) \bullet Y/15|$ respectively.

6.2.4.4.3 Test image 3

This shall consist of a palettised, pseudo-random collection of pixels having various colours. Each image shall be generated by the following algorithm:

1. Pseudo-randomly select a value for I such that I is a real number on the interval $^1/_8 \le I < {}^1/_8$.
2. For each of the variables ρ, γ and β pseudo-randomly allocate one of the probabilities 0,78, 0,16, 0,04 and 0,02 to each of the numbers $^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$.
3. For each pixel in the image pseudo-randomly select a value for each of ρ, γ and β, with the allocated probabilities, from the numbers $^1/_8$, $^3/_8$, $^5/_8$ and $^7/_8$.
4. For each pixel set $r = I + \rho$, $g = I + \gamma$ and $b = I + \beta$.

6.2.4.5 Colour errors

6.2.4.5.1 Test method

For every pair *(i)* of input and output pixels, within each input and output rectangle that each contain (α) such pixels, the colour error ($C\varepsilon_i$) is represented as

$$C\varepsilon_i = \left[u\left(r_{(in)i} - r_{(out)i}\right)^2 + v\left(g_{(in)i} - g_{(out)i}\right)^2 + w\left(b_{(in)i} - b_{(out)i}\right)^2 \right]^{1/2}$$

Where u = 0,089401, v = 0,344569 and w = 0,012996, being the squares of the ITU weightings for converting RGB values to luminance values.

The colour test metric (TM_c) is then: $TM_c = \alpha^{-1} \sum_{i=1}^{\alpha} C\varepsilon_i$

6.2.4.5.2 Result required

It is required that $TM_c \leq 0.05$ for each of the n^2 rectangles in the image.

6.2.4.6 Positional errors

For each of the n^2 rectangles of the input test image having their corners at j,k, there will be a corresponding output rectangle, whose bottom left hand corner is at p_{jk},q_{jk}, that was specified by the manufacturer. It will probably be, but not necessarily the output rectangle that gave the smallest value of Tm_c. It shall be that which passed the tests of 6.2.4.5.

All positional errors are functions of some of the variables j, k, p_{jk} and q_{jk}. The test technique is to consider the pairs of data points j,p_{jk} and k,q_{jk} where, for each of the n values of k, there are n sets of j,p_{jk} and, for each of the n values of j, there are n sets of k,q_{jk}.

The j,p_{jk} set defines any horizontal position errors and the k,q_{jk} set defines any vertical position errors.

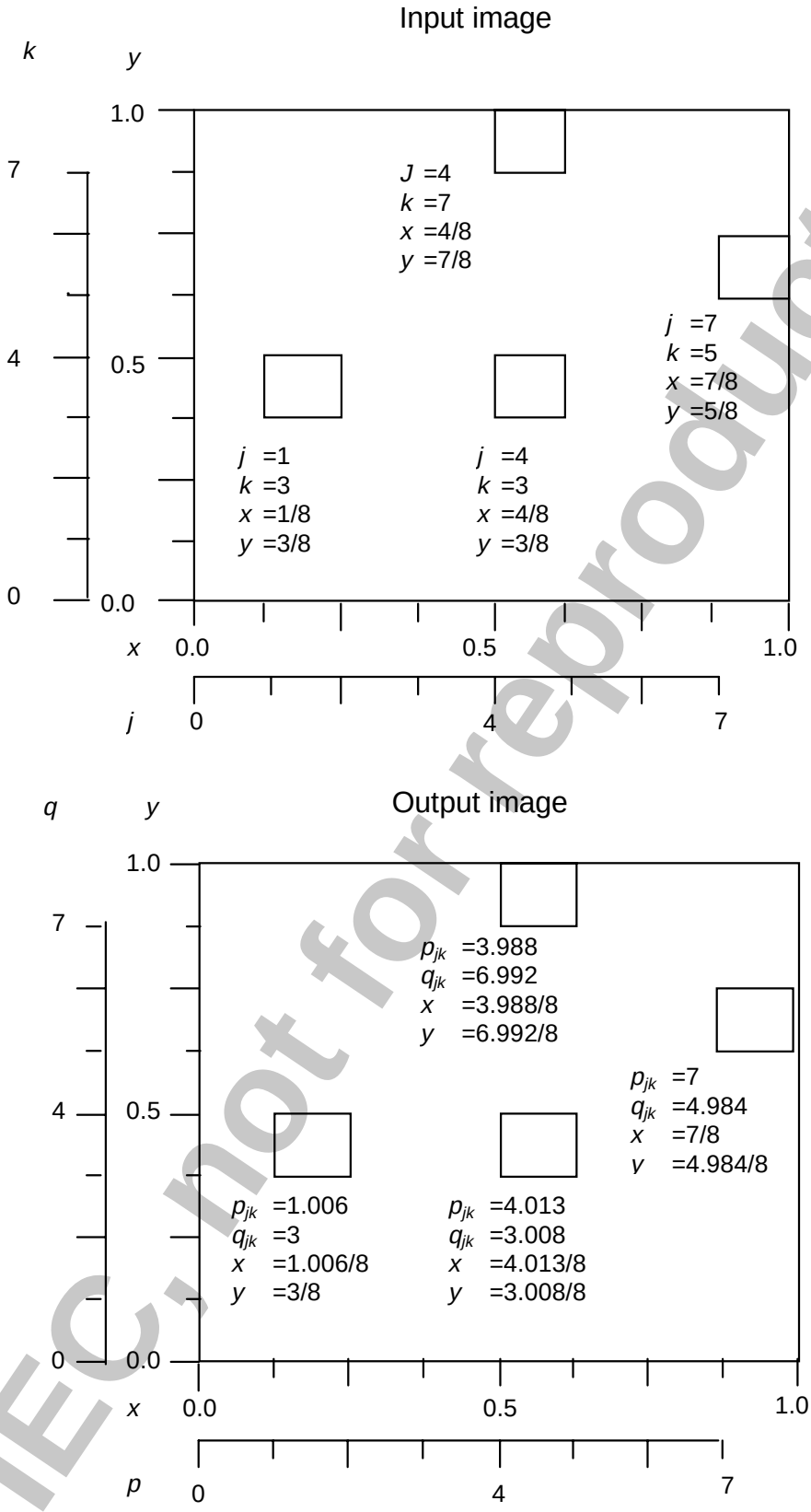

Figure 2 – Comparison of images

6.2.4.6.1 Horizontal position errors

6.2.4.6.1.1 Test method

For each of the *n* values of *k*, there will a row of rectangles on the input image each of whose left hand edges are defined by the *n* possible values of *j*. For convenience and consistency of notation, *set I = j, x = j/n* and $y = p_{jk}/n$.

If there are no positional errors then $y_I = x_i$ for all *i*, in terms of a linear equation $y_I = mx + c$, where $m = 1$ and $c = 0$. That will not be the case if there are horizontal positional errors. In that case there will be a best-fit line, of form $y = mx + c$, that has some of the data points lying off the line. The test technique is to set limits on the values of *m* and *c* (to limit linear offsets and scalings) and also on the amount by which data points can be displaced from the line (to limit non-linearities).

The possible errors are that the image can be scaled by some constant ($m \neq 1$), offset by some constant ($c \neq 0$) or displaced by different amounts at different parts of the image.

Where $y = mx$ + c is the best-fit line, there will be *n* values of y_i that have a horizontal error:

$$X\varepsilon_i = \left| mx_i + c - x_i \right|$$

The *X* linearity test metric TM_x is the mean value of all $X\varepsilon_i$ where 0 ≤ I = j ≤ n-1.n-1:

$$TM_x = n^{-1} \sum_{i=0}^{n-1} X\varepsilon_i$$

6.2.4.6.1.2 Required result

It is required that $0{,}99 \leq m + c \leq 1{,}01$ and that $-0{,}01 \leq c \leq 0{,}01$ for each of the *n* rows of rectangles indexed by *k*.

It is required that $Tm_x \leq 0{,}002$ for each of the *n* rows of rectangles indexed by *k.*

In addition, because it would be undesirable to have any discontinuities within the image, it is required that $\left| (mx_I + c\text{-}y_i) - (mx_{i+1} + c\text{-}y_{i+1}) \right| \leq 0{,}005$ for all values of $i, 0 \leq I = j \leq n\text{-}2$.

NOTE – For clarity the discontinuity expression is not simplified.

6.2.4.6.2 Vertical position errors

6.2.4.6.2.1 Test method

For each of the *n* values of *j*, there will be a row of rectangles on the input image each of whose bottom edges are defined by the *n* possible values of *k*. For convenience and consistency of notation, set $I = k$, $x = k/n$ and $y = q_{jk}/n$.

Hereafter, the analysis and method of test is the same as that used for horizontal errors.

If there are no positional errors then $y_I = x_i$ for all *i*, in terms of a linear equation $y_I = mx + c$, where $m = 1$ and $c = 0$. That will not be the case if there are vertical positional errors. In that case there will be a best-fit line, of form $y = mx + c$, that has some of the data points lying off the line. The test technique is to set limits on the values of *m* and *c* (to limit linear offsets and scalings) and also on the amount by which data points can displaced from the line (to limit non-linearities).

The possible errors are that the image can be scaled by some constant ($m \neq 1$), offset by some constant ($c \neq 0$) or displaced by different amounts at different parts of the image ($m_I \neq m_{i+1}$ or $c_I \neq c_{i+1}$ for all I).

Where $y = mx + c$ is the best-fit line, there will be n values of y_i that have a vertical error

$$Y\varepsilon_i = \left| mx_i + c - y_i \right|$$

The Y linearity test metric TM_y is the mean value of all $Y\varepsilon_i$ where $0 \leq I = j \leq n\text{-}1$.

$$TM_y = n^{n-1} \sum_{i=0}^{n-1} Y\varepsilon_i$$

6.2.4.6.2.2 Required result

It is required that $0{,}99 \leq m + c \leq 1{,}01$ and that $-0{,}01 \leq c \leq 0{,}01$ for each of the n columns of rectangles indexed by j.

It is required that $TM_y \leq 0{,}002$ for each of the n columns of rectangles indexed by j.

In addition, because it would be undesirable to have any discontinuities within the image, it is required that

$\left| (mx_I + c - y_i) - (mx_{i+1} + c - y_{i+1}) \right| \leq 0{,}005$ for all values of i, $0 \leq I = k \leq n\text{-}2$

NOTE – For clarity the discontinuity expression is not simplified.

6.2.4.7 Subjective evaluation

6.2.4.7.1 Test method

A series of images[1], representative of recordings from a shipborne radar, including ones having small groups of isolated pixels, shall be recorded. These shall be played back alongside the original images. An experienced marine radar observer shall be called upon to compare the original and the recorded images.

6.2.4.7.2 Result required

It is required that, in the professional opinion of the marine radar observer, the original and the recorded images are identical with regard to all operational respects.

[1] It is intended to develop the detail of these images during the CDV period, with the intention of making them available e.g., on the world wide web and including the necessary detail of their location in this standard.

6.2.4.8 Echo sounder – main alarms – rudder order and response – engine order and response – hull openings (doors) status – watertight and doors status – acceleration and hull stresses – wind speed and direction (A.861/5.4.8 – 5.4.15)

6.2.4.8.1 Test method

The test method and result required is identical in all the items in 6.2.4.8.

Present the data, item by item, conforming to the format specified in 5.8.2.1 to the port designated for the specific item. The data shall be presented at a rate greater than once per second and changed at a rate less than once per second. Record the data for 30 minutes. Replay the data.

6.2.4.8.2 Result required

It is required that all the changed data are accurately reproduced at a rate of at least once per second.

6.3 Interfacing

The manufacturer shall demonstrate that all interfaces meet the requirements of 4.3.6 and 5.5.1.5.

Annex A
(informative)

Bibliography

IEC 60936-1: 1999, Maritime navigation and radiocommunication equipment and systems – Radar – Part 1: Shipborne radar – Performance requirements – methods of testing and required test results

IEC 60936-3: – , Maritime navigation and radiocommunication equipment and systems –Radar – Part 3: Radar with chart facilities – Performance requirements – methods of testing and required test results

ISO 8728: 1997, Ships and marine technology – Marine gyro compasses

ISO/IEC 11674: 1999, Maritime navigation and radiocommunication equipment and systems – Heading control systems

IMO Resolution MSC.74(69):1998, annex 4 – revision of A.224 – performance standards for echo sounding equipment

IMO Resolution MSC.64(67): 1996, annex 4 – performance standards for radar equipment

IMO Resolution A.424: 1979, performance standards for gyrocompasses

IMO Resolution MSC.64(67): 1996, annex 3 – performance standards for heading control systems

IMO Resolution A.526: 1983, performance standards for rate-of-turn indicators

IMO Resolution A.529: 1983, accuracy standards for navigation

IMO Resolution A.600: 1987, IMO ship identification number scheme

IMO Resolution A.612: 1987, performance standards for float-free VHF emergency position-indicating radio beacons

IMO Resolution A.662: 1989, performance standards for float-free release and activation arrangements for emergency radio equipment

IMO Resolution A.694: 1991, General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids

IMO Resolution A.754: 1993, recommendation on fire resistance tests for “A”, “B” and “F” class divisions

IMO Resolution A.803: 1995, performance standards for shipborne VHF radio installations capable of voice communication and digital selective calling

IMO Resolution A.805: 1995, performance standards for float-free VHF emergency position-indicating radio beacons

IMO Resolution A.813: 1995, General requirements for electromagnetic compatibility (EMC) for all electrical and electronic ship’s equipment

IMO Resolution A.817: 1995, performance standards for electronic chart display and information systems (ECDIS)

IMO Resolution A.819: 1995, performance standards for shipborne global positioning system (GPS) receiver equipment

IMO Resolution A.823:1995, performance standards for automatic radar plotting aids (ARPAs)

IMO Resolution A 824: 1995, performance standards for devices to indicate speed and distance

Annex B
(informative)

IEC 61162 sentence formats

Parameter to be recorded	Clause(s)	Sentence format $--***	Notes
Date and time	4.6.1	ZDA	
Ship's position and Datum used	4.6.2	GNS and DTM	
Speed (water and/or ground)	4.6.3	VBW	
Heading (true)	4.6.4	HDT	
Heading (magnetic)	4.6.4	HDG	
Depth (echo sounder)	4.6.8	DPT	
Alarms	4.6.9	ALR	
Rudder order/response manual	4.6.10	RSA	note 1
Rudder order/response automatic	4.6.10	HTC and HTD	
Engine order/response	4.6.11	RPM and XDR	notes 1 and 2
Hull openings, watertight doors	4.6.12 & 4.6.13	XDR	note 2
Accelerations and Hull stress	4.6.14	XDR, ALR	note 2
Wind speed and direction	4.6.15	MWV	
VDR alarm output		$VRALR	note 3

NOTES

1 The current specifications for RSA and RPM do not have fields for 'order', only 'response'.

2 The table of transducer types in the current specification for XDR does not specifically include these uses.

3 There is no requirement for the VDR to send alarm messages. If, as an option, such messages are sent, then the appropriate sentence format is ALR.

Annex C
(informative)

Mandatory alarms

IMO resolution A.861 requires in 5.4.9 the recording of “mandatory alarms on the bridge”. This phrase is not defined in any published IMO specification or recommendation. The following list has been drawn up by IEC TC 80 and discussed with representatives of IMO. (see explanatory notes after table C.3)

Table C.1 – IMO instrument: SOLAS Chapter II-1

No	IMO clause	Function	Type of alert	Notes
1	29.5.2 30.3	Main and auxiliary steering gear power units	Audible + Visual	Failure of power to any steering gear power unit. Operation of devices for short circuit protection, overload, loss of phase in 3-phase system
2	29.8.4	Main and auxiliary steering gear control system	Audible + Visual	Failure of power to control system
3	29.12.2	Steering gear, low hydraulic fluid level	Audible + Visual	Low level of fluid in hydraulic fluid reservoir
4	31.2.7 49.5	Propulsion machinery remote control system failure	Audible + Visual	For vessels with bridge control of propulsion machinery and manned engine room; failure of remote control of propulsion machinery
5	31.2.9 49.7	Propulsion machinery low starting air pressure	Audible + Visual	Vessels as 4. Low start air pressure but further starting of propulsion machinery possible
6	52	Automatic shut down of propulsion machinery		Vessels with periodically unattended machinery spaces. Shut down of propulsion and other machinery due to serious malfunction
7	51.1.3	Fault requiring action by or attention of the OOW	Audible + Visual	Vessels as 6
8	51.2.2	Alarm system normal power supply failure	Audible + Visual	Vessels as 6. Failure of normal power supply to alarm plant
9	15.7.3.1 [2]	Watertight door low hydraulic fluid level	Audible + Visual	Passenger ships constructed on or after 1 February 1992 with hydraulic power operated sliding watertight doors. Low level of fluid in hydraulic reservoir
10	15.7.3.1 [2]	Watertight door low gas pressure, loss of stored energy	Audible + Visual	Vessels as 9. Low gas pressure or loss of stored energy in operating hydraulic accumulator
11	15.7.8 [2]	Watertight door electrical power loss	Audible + Visual	Vessels as 9. Failure of electrical power to operating or control system
12	21.1.6.2 [2]	High water alarm	Audible + Visual	High water level in space where water has drained from enclosed cargo space or freeboard deck
13	23-2.1 [2]	Shell door position indicator		Ro-Ro passenger vessels. Door open or locking device not secured. System to have mode switch for ‘sea or harbour’. System active in ‘sea’ mode
14	23-2.2 [2]	Water leakage detection indicator	Audible + Visual	Vessels as 13. Leakage of water into Ro-Ro cargo spaces or special category spaces through shell doors

Table C. 2 – IMO instrument: SOLAS Chapter II-2

No	IMO clause	Function	Type of alert	Notes
15	5.3.4.3 [3]	Local automatic halon release	Audible + Visual	Activation of system to release halon
16	11.8 14.2	Fire detection in automated or remotely controlled machinery space	Audible + Visual	Activation of detection system
17	12.1.2 12.1.2.1 [3] 12.1.2.2 13.1.5 [3] 13.1.6	Fire detection or automatic sprinkler operation	Audible + Visual	Activation of sprinkler or fire detection system. Also additional alarm to show fault or loss of power to either system
18	13-1.1.3 [2]	Smoke detection system power loss	Audible + Visual	Sample extraction smoke-detection systems. Failure of power to the system
19	13-1.4.6[2] [3]	Smoke detection		Equipment as 18. Activation of system
20	5.3.3.8 [3]	Halon system loss of container	Audible + Visual	Decrease in pressure of gas in containers
21	5.3.3.2 [3]	Halon system electric circuit fault or power loss	Audible + Visual	Failure of electric power to circuits connecting containers for gas release
22	5.3.3.3 [3]	Halon system – hydraulic or pneumatic pressure loss		Loss of pressure to pneumatic or hydraulic circuits for gas release

Table C. 3 – IMO instrument: Resolution A.481

No	IMO clause	Function	Type of alert	Notes
23	Annex 2 paragraph 7.3	Personnel alarm	Audible + Visual	Safety. Personnel on watch alone in an engine room or entering a machinery space alone

NOTES

1 These tables do not include the alarms separately identified for specialist vessels such as gas carriers, fishing vessels, nuclear ships, high speed craft or mobile offshore drilling units.

2 Applicable to vessels constructed on or after 1 February 1992.

3 These alarms may be omitted if they are provided at the central fire control station.

_____